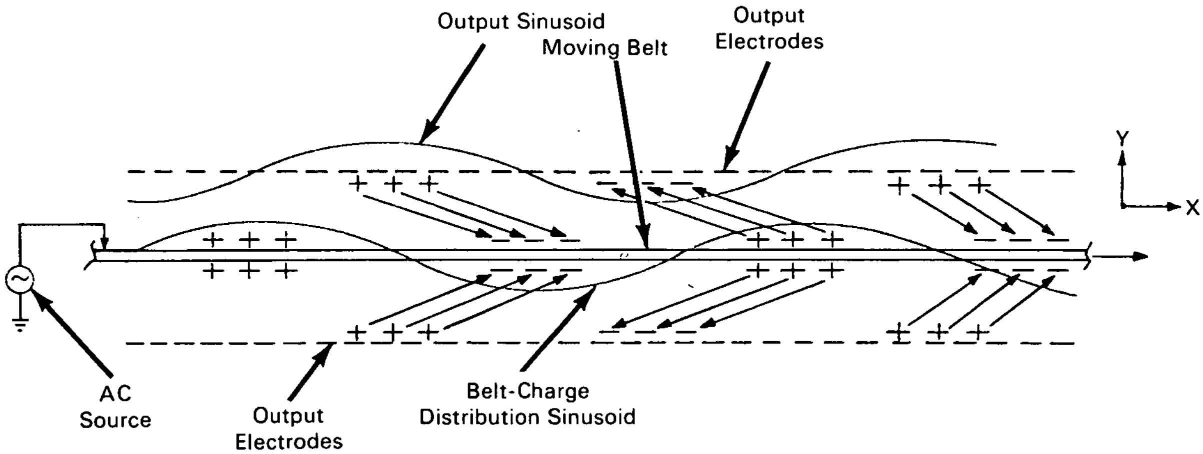
NASA TECH BRIEF

Synchronous Charge-Constrained Electroquasistatic Generator



The problem:

Magnetohydrodynamic (MHD) electric power generators, which have been under development in recent years, use gas or other fluid as the moving conductor. These MHD generators are mainly restricted to dc operation, although self-excited ac systems using liquid (molten) metals or liquid metal-gas media have been built. The latter systems are not suited to synchronous operation, as the electrical conductivities of the liquids are not sufficiently high.

The solution:

A new generator, which has been conceived, depends on electroquasistatic interactions (whereas magnetic interactions predominate in present MHD systems) to provide synchronous operation. The generator may either be excited by an external source of electric potential or self-excited.

How it's done:

The electroquasistatic generator in one form employs a moving insulating belt of the Van de Graaff type, with a source of ac electric potential to establish positively and negatively charged regions on the belt. Segmented pickup or output electrodes are positioned in zones to be affected by the fields of the charged regions but mechanically isolated from these regions. Although the generator is described here primarily with reference to the use of an insulating (high-resistance) belt, it has more general design latitude in that the high-resistance medium may be a liquid or a gas, a two-phase fluid, or a high-resistance solid in the shape of a disk or cylinder. Relative movement is effected between the medium and the segmented output electrodes, the path of the movement being such that the positive and negative regions induce, respectively, negative and positive potentials in the electrodes.

As shown in the diagram, the ac source establishes positive (+) and negative (–) regions on the belt as it moves relative to the source in the x direction. The spatial distribution of charges on the belt is sinusoidal in the x direction as represented in the diagram. The charge accumulations on the belt induce (as indicated by the slanted arrows) upon the output electrodes,

(continued overleaf)

charges of opposite polarities to the inducing charges. The induced charges lag the respective inducing charges by some amount, as represented by the output sinusoid, depending upon the load connected to the output electrodes. Each electrode has a dimension in the x direction that is small compared to the wavelength of the applied potential to provide an output with an integral number of phases. Because of the traveling-wave nature of the interactions, the phase of the output voltage varies with x, and this must be taken into account when paralleling the electrodes of one phase group with corresponding electrodes of another phase group. It is important to note that only the field effect of the charges on the belt creates an ac output voltage. Therefore, the source need provide only enough charge to replenish that charge which has leaked or otherwise been dissipated from the belt. Thus, the charge transfer from the source to the belt is not a primary limitation on the electric current capability of the generator.

By employing a number of parallel connections to the electrodes (positioned between belts) the generator will provide high current capacities. The limit on output power available is determined only by size, insulation strength, and belt velocities. The power output in a 100-belt system is 2.5×10^5 watts in air at atmospheric pressure or 1.4×10^8 watts in nitrogen at 27 atmospheres. Thus, large power blocks would be available at voltages high enough to obviate step-up transformers.

Note:

No further documentation is available. Inquiries may be directed to:

Technology Utilization Officer
Headquarters
National Aeronautics
and Space Administration
Washington, D.C. 20546
Reference: B69-10461

Patent status:

Title to this invention has been waived under the provisions of the National Aeronautics and Space Act [42 U.S.C. 2457 (f)], to the Massachusetts Institute of Technology, Cambridge, Massachusetts 02139.

Source: J. R. Melcher of
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